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A Study of the Response of Chromium Doped Alumina Screens to Soft X-rays Using Synchrotron Radiation

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Beamline(s): X24A

Introduction: Chromium-doped alumina screens (Chromox-6) [1,2] have found application as broadband radiation converters for plasma fusion diagnostics. These screens, which luminescence when irradiated by a broad range of radiation, exhibit high resistance to damage [3]. We measure the response of Chromox-6 screens to soft x ray radiation and derive a quantum efficiency curve for the energy range from 2.5 keV to 4.5 keV. We also characterize the afterglow observed following the removal of the x ray irradiation.

Methods and Materials: A 1 mm thick screen of *Chromox-6* was scanned in 1 eV steps between 2.5 keV and 4.5 keV and its luminescence from the illuminated face, which peaks at 694 nm, was monitored using a visible photodiode. The incident soft x ray intensity was obtained by measuring the replacement current from a nickel mesh and the quantum efficiency was found from the set-up geometry and the response of the monitors. The afterglow was characterized by monitoring the temporal evolution of the luminescence after irradiation. See Fig. 1.

Results: The quantum efficiency curve (photons emitted per incident photon) for reflection mode is shown in Fig. 2 [4]. The measurements can be reproduced to within 3% with a relative uncertainty below 20%. The resultant equivalent light yield is 3.23 10^4 photons MeV^{-1}. The afterglow is approximated by a stretched exponential. Such behavior is also reported for the photoluminescence decay and transport properties of disordered systems such as amorphous semiconductors and glasses and may indicate a random distribution of trapping centers [5].

Conclusions: The measured equivalent light yield of *Chromox-6* lies between those of some common phosphors *e.g.* P-46 (1.4 10^4 MeV^{-1}) and P-43 (5.7 10^4 MeV^{-1}). Afterglow can be suppressed by suitable co-doping, albeit with some loss of efficiency [6]. The radiation hardness and good efficiency of this material warrant further investigation on the suppression of its afterglow.

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References:

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[2] Certain commercial equipment, instruments, or material are identified here to foster understanding. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment are necessarily the best available for the purpose.
[3] K. J. McCarthy, A. Baciero, B. Zurro, U. Arp, C. Tarrio, T. B. Lucatorto, A. Moroño, P. Martín and E. R. Hodgson, "Characterization of the Response of Chromium Doped Alumina Screens in the Vacuum Ultraviolet using Synchrotron Radiation", in print: *J. Appl. Phys*. (2002).
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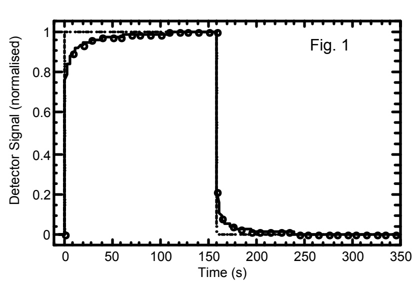

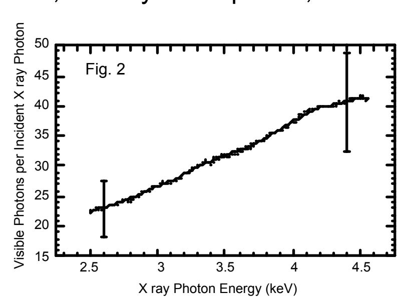

Fig. 1. The temporal evolution of the normalized photodiode signal during and after irradiation of *Chromox-6* by 2.5 keV x rays.
Fig. 2. The *Q.E.* of Chromox-6 for reflection mode of operation. No elemental absorption edge features are present.